Rhinoceros®

NURBS modeling for Windows

Curriculum and Instructor's Guide
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Rhino Curriculum and Instructors Guide.doc

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Curriculum Guide

This guide provides curriculum ideas and other helpful suggestions for computer graphics, drafting, design, engineering, manufacturing, and art instructors who want to incorporate Rhinoceros® NURBS modeling for Windows into their program. The guide includes curriculum ideas as well as a complete sample 15-week syllabus. Use as much or as little from this guide as you need, or modify it to fit your particular needs. This guide gives you a starting point for teaching 3-D modeling. If you choose to customize the guide, the original document in Microsoft Word 97 format, is available for download from the following web site: *http://www.rhino3d.com/eduresources.htm*.

Rhino can be used in almost any curriculum that teaches 2-D layout or 3-D modeling. This guide uses design/problem solving activities as well as step-by-step instruction to teach NURBS modeling.

Rhino is a powerful design and visualization tool you can use with most computers running Windows 95/98 or NT. Use it to create designs and 3-D images that would be difficult to make or take a very long time with other CAD or drawing programs. Rhino lets students create models quickly without having to go through weeks of instruction before they can make something that is precise and looks realistic. Many students can create simple models in less than ten minutes after some demonstration and instruction.

Students can continue beyond modeling. Once a model is completed in Rhino, it can then be used with other applications to further enhance a project. For example, students can create a model and export the file to a CNC machine for prototyping or manufacturing or render a 2-D view of the model and use it on Web pages, newsletters, and presentations. Models can be exported to other software programs for animation.

The biggest decision to make is your approach to teaching Rhino. We will discuss two approaches in this document: *technical proficiency* and *technical adequacy*.

Technical Proficiency

Technical proficiency is learning NURBS modeling as a subject using Rhino. It requires a structured approach to learning. Each command and technique is presented and practiced on a daily basis. The following sample schedule is based on using the *Rhino Level 1 Training Manual* as a textbook. Students will become familiar with most of the commands available in Rhino before they begin their design projects. The sample schedule can be modified to take from four to six weeks to cover the basics of Rhino.

This approach allows for mastery of the program with fewer projects. While this approach requires more structured class time to learn the software, they will have a broad range of skills in which to complete any project.

Customizing Rhino workspaces and toolbars is not recommended for classes with multiple sections using the same lab. Skip Part Four of the *Level 1 Training Manual*.

Sample Schedule

Week	Subject	Training Guide Section
1	Rhino basics Create two-dimensional objects Simple editing commands	Pages 1-46
2	Precision modeling	Pages 47-116
3	Editing	Pages 117-218
4	Solids modeling Surface modeling	Pages 219-354
5	Importing and exporting Printing Rendering	Pages 355-392
6–18	Projects (See examples starting on page 9.)	

Technical Adequacy

Technical adequacy is using Rhino as a tool. It requires students to learn only those commands that will help them finish a project. Only the most frequently-used commands and techniques will be presented. Other commands will be learned as needed ("just-in-time" learning).

With this approach, students will be involved in more projects and will learn how to model in Rhino through problem solving activities.

The following sample schedule represents the most common commands used to make most of the objects students will want to model. There are advanced tools that will let them get greater precision and accuracy with their design, but these can be left for later.

Demonstrating a command can take as little as five minutes. The total time used to teach Rhino can be as little as two and a half weeks or as long as a quarter. Once students see how it works, they can practice and create designs with each new tool. It is important that students not only create designs that are assigned to them, but also be allowed to make their own.

Sample Schedule

This guide breaks down the basic Rhino commands into several main areas. Each area contains step-by-step instruction and design activities that help reinforce previously learned commands. The purpose is to get students to draw real-world objects quickly. Notice that this approach lets you introduce students to a wide variety of commands in the first week and gets them started with modeling very quickly. With this method you should use the *Rhino Level 1 Training Manual* as a reference.

Week	Operation	Commands	Activity/Project
1	Basic interface	Command line, changing viewports, Zoom, Pan, Undo/Redo	First model.
	Solid primitives	Cone, Sphere, Box, Cylinder, Torus, Ortho mode, and Shade	
	Basic editing	Move, Copy, Rotate, Delete, Mirror, Scale, and Object Snaps as needed	
	Boolean operations	Union, Difference, Intersection	Flashlight, alarm clock, camera, table, or stool.
	Rendering	Properties, Spotlight, Render	Create light and shadows on previous design activity and all future design activity.
	Creating curves and surfaces.	Line, Curve, Arc, Trim, Join, and Revolve	Drinking/wine glass, soda can, water bottle, Frisbee, baseball bat, vase.
	Extruding surfaces	Circle, Ellipse, Extrude	2-D text of personal name, a product, a slogan, or slang.
		Rectangle, Rounded Rectangle	Create various 2-D surfaces (cookie cutter shape). Extrude them both straight and along a curve. Extrude 2-D text from previous activity.
2	Practice	Commands from week 1	Desk lamp, Christmas bell, ink pen, pool table, screwdriver, flower pot, coffee mug.
	Advanced editing tools	Fillet, Cap Planar Holes, Array	Floppy disk, Zip disk, computer monitor, TI calculator.
3	Sweeping surfaces	Sweep 1 Rail, Sweep 2 Rail Sweep to a point option	Pipes and tubes with various diameters along a path. Animal tail, octopus, banana, headphones, stapler.
	Lofted surfaces	Loft, Dir, and Flip commands	Boat hull, canoe, airplane wing, game pad/joystick, skateboard, telephone.
4	Making squishy surfaces	Control point editing	Rubber ducky, food, other organic shapes.
5	Design activities	All of the previous commands and new commands as needed	Projects. (See examples starting on page 9.)

Sample Course Outline

Course Overview

This course introduces students to the features and functionality of Rhinoceros, a NURBS modeler.

Prerequisite: Students should have a general knowledge of operating standard applications under Windows. This includes logging in (for networks), launching applications, finding drives, managing files and navigating menus and dialogs.

Objectives

Upon completion of this course, the student will be able to:

- Understand 3-D modeling concepts.
- Use commands and capabilities of Rhino.
- Set up a 3-D scene and view 3-D space.
- Create basic geometry including curves, solids and surfaces.
- Define properties.
- Place lights and render scenes.

Resources

The *Rhinoceros User's Guide*, the *Rhinoceros Level 1 Training Manual*, and Web resources on 3-D modeling (*http://www.rhino3d.com/students*).

Evaluation

Students will be evaluated on the basis of timely completion of projects planned and outlined according to a class handout.

Examinations

The mid-term and final examinations allow students to apply learning and put everything together to develop a complete scene including all the objects they have created in class. The minimum requirements are covered in the handout. Advanced students are encouraged to add enhancements, which could be an outdoor scene including table, table cloth, glasses, plates, utensils, or whatever they choose.

Examination Peer Review

Each completed scene for the examination should be rendered. When all images are rendered, students will review the work on other student's monitors, ask questions, and learn various techniques from their classmates. Ballots will be distributed and the three best scenes will be awarded a certificate of merit. Winners should save or archive their Rhino file and a BMP or TIF file of the rendered image to a floppy. Include name and the date on the label. These files will be used as examples for other students and may be posted on an Internet gallery.

Design Activities Process

All of the sample activities are based on the following design problem format:

- **Problem statement**—Give a scenario and the task students must solve.
- **Limitation/parameters**—These are the things like materials used, time, cost, boundaries of the design solution and other information affecting the final design.
- **Brainstorm** solutions—Sketchy, hand drawn ideas. Set a minimum number expected.
- **Select best one**—Should provide rationale of their selection.
- **Develop idea/prototype/finalize** idea—This is the "just do it" phase.
- **Test/evaluate** solution—Should provide an analysis on the design and any conclusions.
- **Redesign/retest** if possible—Time consuming, but valuable experience.
- **Presentation—**Finished assignment presented to the class.

Instructions

Organizing the activity

Instructor	Student
Arrange students into groups (details on page 7).	Students get into groups and go to tables.
Instruct students on the design challenge (give them the problem handout). Make sure they understand the parameters of the designs (See examples starting on page 9).	Read the handout.
Instruct them to begin drawing ideas on paper. Instruct them to model in Rhino.	Students begin drawing their designs on paper and modeling their products on the computer.
Instructor walks around to answer questions and provide guidance as necessary.	Students continue modeling.
Review objects with students to determine if they meet the design parameters. If not, have them fix. Peer review (see page 5).	Students analyze their material against the parameters to insure it meets the criteria.

Instructional materials

- Display examples of similar products.
- Try to include items of different shapes, materials, and sizes.
- Have magazines and newspapers that contain advertisements of various products available as idea starters.

Anticipatory set

- Have materials set up on desks before students enter class.

Multi-level class

When your class includes students with computer drawing experience varying from basic to advanced, you will have to do some grouping.

Students with similar experience form groups and work together as a team. Students can be separated into levels—basic, intermediate and advanced. The example below is based on the bottle design activity on page 18. Minimum objectives for each group are shown in the following table:

Levels	**Rhino Capabilities Used** (Basic Navigation and following:)	**Type of Bottle** (Required)	**Other Projects** (Or other objects chosen)
Basic	Line/Curve Solid primitives Boolean operations Revolve Rendering	Any bottle	Glasses filled with a liquid
Intermediate	All above and the following: Extrude Sweep Transparent materials rendering	Bottle with wall thickness	All above and following: Table Chairs
Advanced	All above and the following: Lofts Control points and set points Surface tools Text tools and projection Rendering of materials	Irregularly shaped bottle with label	All above and following: Interior walls Floor and windows

Ideas for Design Assignments

One of the best ways to get students to learn how to use Rhino is to have them make real-world objects. Encourage them to figure out how to break down an object into various modeling operations and then do it with precision. Here are some examples to give to students so they can practice their skills:

Entry-Level	**Intermediate**	**Sophisticated**
Kleenex box	Tube of toothpaste, toothbrush	Car, truck, train
Pen/pencil	Computer, monitor, printer	Roller blades
Pop can/bottle	Headphones	Ship/boat
Dice (4, 6, 8 sided)	School desk, office chairs	Bicycle
Flower vase	Watch, alarm clock	Animals
Stool	VCR, CD player, stereo	Sunglasses, safety glasses
Table with objects on top of it	Dishes/pots & pans	Tennis shoe
Drinking cups	Stove/dishwasher	Airplane, helicopter
Christmas ornaments	Lipstick, mascara, perfume bottle	Computer mouse
Squirt bottle	Overhead projector	Piano, musical instruments
	Hammer, wrench, pliers	Skull/bones

Entry-Level	Intermediate	Sophisticated
Screwdriver, nails, clamps Jewelry box CD case Radio, speakers Table or desk lamp	Floppy disk Calculator Electric wheel chair Telephone	Child's pull toy Hat, helmet Humanoid Cell phone, remote control

Example Problem Statements

- Design a new soda drink holder for movie theaters.
- Design a new screwdriver that allows for both a Phillips head and flat head.
- Design a wooden toy that is adequate and safe for kids ages 8 to 12. It should be based on a theme.
- Design your dream vehicle (plane, car, train, boat, space craft)
- Design two blocks that will fit into each other using holes and posts that line up. Two teams design each block and communicate the design specifications.

Sample Design Activities

Two of the activities included are modifications of the examples from previous activities. They have been included to show how small modifications can alter a project and to show how the finished product can vary from program to program.

Evaluation

A grading rubric is also included as a possible guide to what can be expected from students. It reflects one instructor's bias toward achievable excellence. The grading scale can be interpreted as 4.0=A, 3.0=B, 2.0=C, 1.0=D, 0.0=F. In this scale, half points could be interpreted as pluses or minuses.

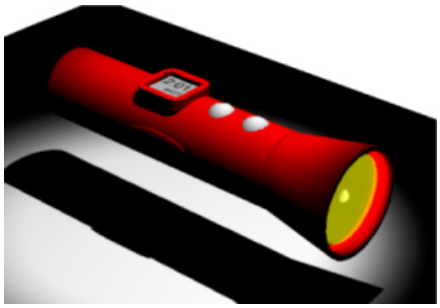
Grading Rubric

Unique/innovative design AND All of the elements presented excellently	4.0 points
All of the elements presented well	3.5 points
Most of the elements adequately presented	3.0 points
Some of the elements adequately presented	2.0 points
Some of the elements shown	1.0 points
None of the elements adequately presented	0.0 points

Example 1 — Flashlight

Problem Statement

You are working for an industrial design company that creates new product ideas for a major outdoor/camp gear manufacturer. You have been given the task of designing a new rugged flashlight that incorporates a digital clock and alarm for campers. It should also include a battery life indicator.



Parameters

You have been given the following limitations from the manufacturer

- Should be lightweight for easy hiking.
- Clock should be incorporated seamlessly into the flashlight design.
- Controls for the clock should be simple and easy to use.
- Should be able to see clock in the dark.
- Need a design in five days.

Brainstorm

Brainstorm at least three different flashlight designs—hand drawn sketches.

Select Best One

Select the best flashlight—give your reasons for that selection.

Develop idea

Develop your flashlight design further by producing several model files and renderings in Rhino.

Test/Evaluate

Evaluate your flashlight against the parameters, change anything if necessary.

Presentation

Present your flashlight design to the class or "client."

Example 2 — Flashlight II

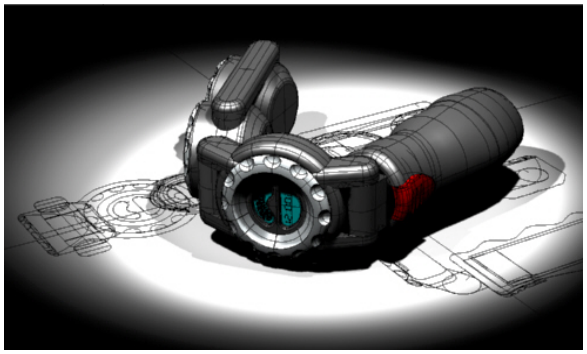
Problem Statement

You are working for an industrial design company that creates new product ideas for a major outdoor/camping gear manufacturer. You have been given the task of designing a new rugged flashlight that incorporates a digital clock and alarm for campers. It should also include a battery life indicator.

Parameters

You have been given the following limitations from the manufacturer:

- It should be lightweight for easy hiking.
- Clock incorporated seamlessly into design.
- Controls for clock should be easy to use.
- It should be simple and easy to use.
- Should be able to see the clock in the dark.
- It will use C-cell, D-cell, or 9-Volt batteries.
- Need a design in 5 days.



Brainstorm

Brainstorm at least three different flashlight designs—hand-drawn sketches and simple Rhino drawings.

Select Best One

Select the best flashlight—give your reasons for the selection.

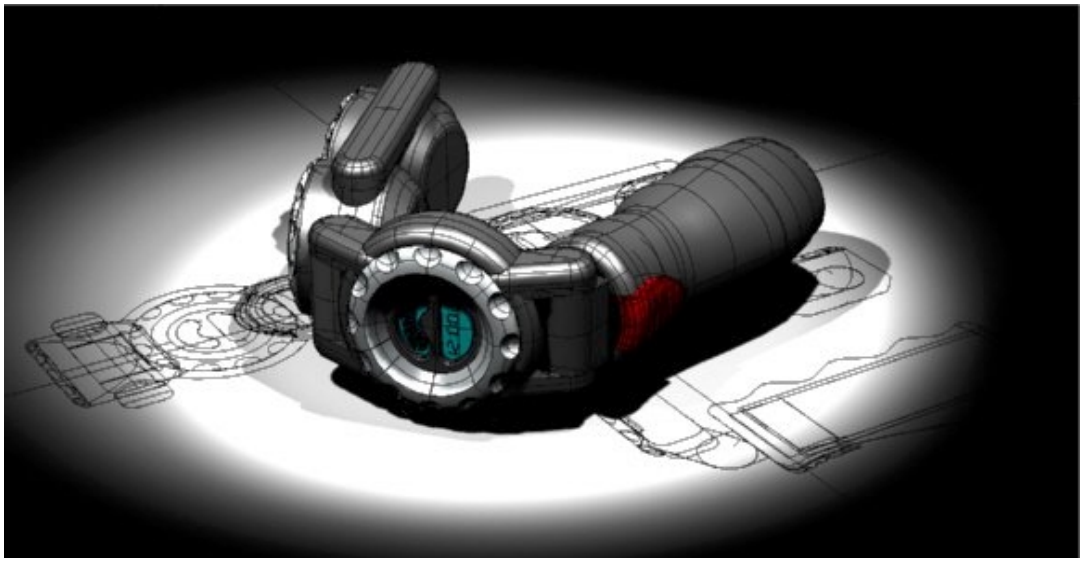
Presentation

Present your flashlight design to the "client" in the form of a specification sheet(s) and working drawing(s) (dimensioned 3-view drawing). Tell what materials were used and give overall dimensions in specification sheet. Include rationale for selection of final design. Include sketches and notes.

Sample Presentation

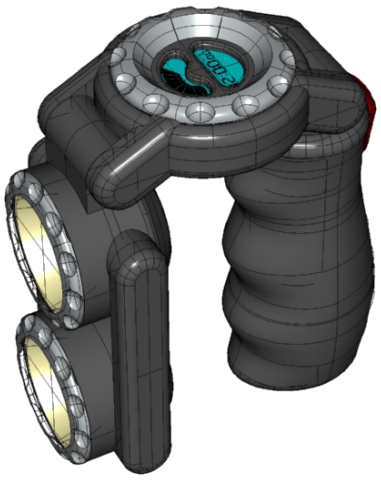
The following sample of a finished flashlight project is included to show what quality can be expected from students. The Ultimate Flashlight (T.U.F.) was created by Shane Winter, Cedarcrest High School (1999). The format of his written portion of the project is given as an example specification sheet that students can produce.

THE ULTIMATE FLASHLIGHT



Unique Design:

- Dual shock-mounted xenon bulbs
- Multi-hinged body
- Red light night-vision filters



Features List:

- Rubber coated, form-fitting handle
- O-ring sealed, water impervious design
- Retractable tripod
- Battery meter
- 12 and 24 hour time
- Alarm
- Timer
- Stopwatch
- Large red on/off button
- Operates on 2 C-sized batteries

Overall Dimensions:

- 6.5" x 5.0" x 3.0"

Materials:

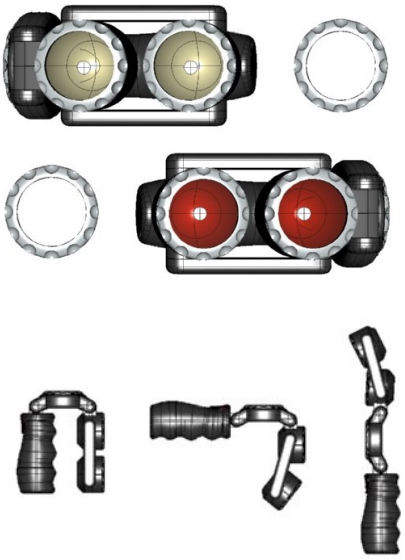
- Machined aluminum
- High-impact ABS plastic

How Tough is T.U.F.?

Constructed of machined aluminum and high-impact ABS plastic, this flashlight will surely take a beating. The dual rubber-mounted xenon bulbs will provide ultra-bright light, hit after hit. The O-ring sealed compartments will keep the water where it belongs—outside.

Unique Features—Deluxe Dual Bulb System and Hinged Body:

The most obvious feature of The Ultimate Flashlight (T.U.F.) is the unique use of two complete light systems. This, along with providing more overall light, provides for a number of useful features that other flashlights simply cannot provide. Two complete lighting systems provide twice as much light as normal flashlights. The second light can also serve as a backup bulb in case one fails. The hinged body also makes it possible to light two different areas at the same time. Trail walkers can light the path and the trail ahead. Poseable hinges allow for a multitude of configurations. The formed and rubberized handle can be used held horizontally, like standard flashlights, vertically like a pistol grip, or anywhere in between so that the hand can be in a comfortable and natural position. With any handle position, T.U.F. retains the ability to point both its lights in any direction(s). By using the retractable tripod, it possible to use both hands while lighting desired areas.

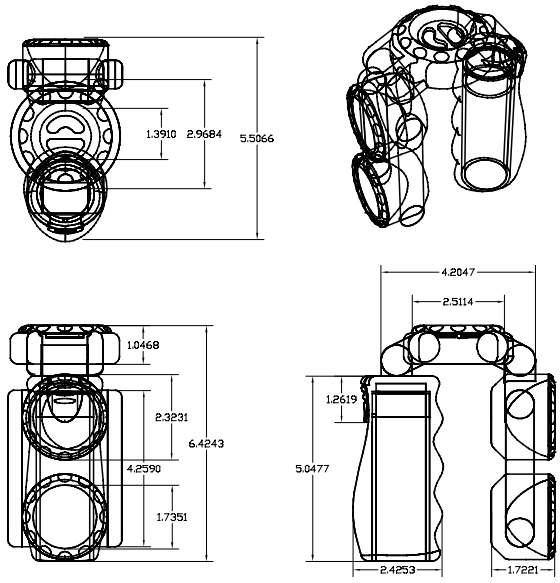


Instant Red Light:

For those jobs that require the retention of night vision, such as map reading, each bulb has an integrated red light filter. To switch between full-white and night-red, the user needs only to twist the ring on the front of each bulb case; no messing with colored filters that inevitably get lost.

T.U.F. Convenience:

As convenient as it is versatile, the T.U.F. light also has a built-in battery meter and full function timepiece, including 12- and 24-hour time, alarm, timer, and stopwatch. And in the dark, the electro-luminescent back light makes reading these displays easy.



Dimensioned drawings

Example 3 — Cosmetic Packaging

Problem Statement

You have been hired by a new company in the high-end beauty industry. You are to create packaging for their line of "Elixir" cosmetics. These products are expensive, so the packaging should promote a luxurious image. Your team will create a container for renewing/anti-wrinkle lotion ("Eden").

Ed Hawkins, La Crescenta, California, USA.

Parameters

Your design must adhere to the following limitations:

- Should be very aesthetically appealing
- Must have a screw-top lid
- Base of container must be glass (somewhat transparent)

Brainstorm

Brainstorm at least three different container designs—hand drawn sketches.

Select Best One

Select the best container—give your reasons for that selection.

Develop idea

Develop your container design further on Rhino.

Test/Evaluate

Evaluate your container against the parameters, change anything if necessary.

Presentation

Present your container design to the class or "client."

Example 4 — Key Chain I

Problem Statement

Your school wants to sell a set of key chains for this school year. The ASB has found a company that will make it for them. ASB officers have heard that you know how to design things using Rhino. They want you to come up with a mock-up design for the key chain. They will then take that design to the manufacturer who will take your drawing and made the key chain. The key chains have to be designed within specific requirements. These requirements must be met and approved by the ASB before the production.

Parameters

- The material must be made from plastic.
- The over all size should be no more than 1/8" thick. The width and height of this key chain should be 1" by 1".
- One side of the key chain should display the school logo and the other side should display the current school year. They would like you to come up with a logo and neat design for the year that will fit in the limited space.
- It must be low in cost, probably selling retail for less than $2.00.
- Need a design in five days.

Brainstorm

Brainstorm at least three different key chain designs—hand drawn sketches.

Select Best One

Select the best key chain—give your reasons for that selection.

Develop idea

Develop your key chain design further on Rhino.

Test/Evaluate

Evaluate your key chain against the parameters, change anything if necessary.

Presentation

Present your idea to the ASB officers.

Example 5 — Key Chain II

Problem Statement

Your school wants to sell a set of key chains for this school year. The ASB has found a company that will make it for them. ASB officers have heard that you know how to design things using Rhino. They want you to come up with a mock-up design for the key chain. They will then take the design to the manufacturer who will take your drawing and make the key chain. They key chain must be designed within specific requirements. These requirements must be met and approved by the ASB before the production.

Parameters

You have been given the following limitations from the ASB:

- The key chain will be made of plastic.
- The maximum overall size is 1" x 1" x 1".
- One side of the key chain should display the school logo and the other side should display the current school year. The ASB would like you to come up with a logo and design for the year that will fit in the limited space.
- It must be low cost, probably selling retail for less than $2.00.
- Need a design in five days.

Brainstorm

Brainstorm at least three different key chain designs—hand-drawn sketches and simple Rhino drawings.

Select Best One

Select the best key chain—give your reasons for the selection.

Develop the idea

Develop your key chain design further by producing several models and renderings in Rhino.

Presentation

Present your key chain design to the "client" in the form of a specification sheet(s) and working drawing(s) (dimensioned three-view drawing). Tell what materials were used and give overall dimensions in specification sheet. Include rationale for selection of final design. Include sketches and notes.

Example 6 — Room Identification Project

Problem Statement

The administration is tired of trying to figure out who is in what classroom and what classes are being taught in that room. They want to install a system of identification for who is in a classroom and what is being taught there each period during the day. It should be simple to read and easy to modify during the school year. Your project is to come up with a system or method of solving this problem and then model and render examples in Rhino.

Parameters

You have been given the following limitations regarding the design of the project.

- The system must contain a picture of the instructor who is in the classroom.
- The system must show what class is being taught during each period.
- You must show the room name or identification number.
- If more than one instructor uses the room, develop a method for identifying all of the people using the room.
- It should be easy to modify the information during the school year.

Brainstorm/Select Best One

Using your freehand sketching techniques, draw at least three concepts with notes identifying your ideas and then select the design you would like to pursue and show the choice to your instructor. You should be prepared to justify your selection to your instructor.

Develop idea/Test and Evaluate

Using Rhino, develop a model and render your selection. Discuss solution with your team members and make any changes that might be necessary.

Presentation

Present your idea to the school administration.

Example 7 —Whirl Bottle

Problem Statement

A beverage company has contracted with your design firm to create a distinctive new bottle and identity for their newest beverage, *Whirl*. The beverage taste will be revolutionary and they need an image that will distinguish *Whirl* from the crowd.

Parameters

The bottle is to be light gray glass with a wrap-around-plastic label. You are allowed complete freedom to create the bottle shape, label, and packaging. The company needs promotional materials that will be used for initial marketing. Before making molds, printing or anything, they want to look at design ideas.

The project places you in the designer's chair on a critical schedule to complete a rendering of the finished product. You must consider your capabilities, the time you have available and outline a project plan within a week. Your firm fortunately has 3-D modeling capabilities, which allows you to make the bottle with a computer. The marketers can then unleash their *Whirl in the World* campaign.

Brainstorm

Using your freehand sketching techniques, complete three sketches of potential designs with notes identifying your ideas.

Select Best One

Select the design you would like to pursue and show the choice to your instructor. You should be prepared to justify your selection to your instructor.

Develop idea

Using Rhino, develop a model and render your selection.

Test and Evaluate

Discuss solution with your team members and make any changes that might be necessary.

Presentation

Present your idea to the class or "client." The scene that you create should show the bottle in a realistic setting that would make you want to stop and have a drink. You can show the bottle alone on a table or create a scene with glasses filled with *Whirl* or whatever scene you can imagine.

Example 8 — Cellular Phone

Problem Statement

Personal technology will undergo dramatic changes in the near future. The size of the electronics will be reduced to approximately 60% of the current size. Design a personal electronic device that incorporates cellular phone, pager, pocket PC/organizer and that takes advantage of the electronics size breakthrough. Make sure that your design takes into consideration ergonomic and other practical considerations. Also come up with a name for the new technology.

Parameters

You have been given the following limitations from the manufacturer:

- It should be aesthetically appealing.
- Must be practical for people with large fingers or small.
- Should be ergonomically sound.
- Should fit into the front shirt pocket without much bulge.
- Need a design in 10 days.

Danny Abell, Duvall, Washington

Brainstorm and Research

Brainstorm at least two different cellular phone designs—hand-drawn sketches and simple Rhino models. Research size of current technology (electronic parts most important).

Select Best One

Select the best device—give your reasons for the selection.

Develop the idea

Develop your device design further by producing several models and renderings in Rhino.

Presentation

Present your device design to the "client" in the form of a specification sheet(s) and working drawing(s) (dimensioned three-view drawing). Tell what materials were used and give overall dimensions in specification sheet. Include rationale for selection of final design. Include sketches, notes, and relevant research. The research should be synthesized into a readable document not just the print out of a web page.

Example 9 — Video Game Concept

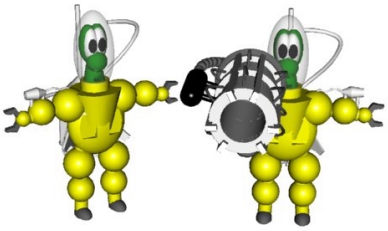
Problem Statement

You have decided to start up a new computer game company. Investors are willing to back up your project if you can develop a theme, design some characters, and make some scenes. It will be a role playing or action adventure game with at least five to ten "base" characters. Come up with a theme for the game, develop the characters, and make some scenes.

Parameters

You have been given the following tasks from your investors:

- Determine a segment of society that will be your target market.
- Come up with a theme for the game.
- Develop a main character and at least four other characters.
- Back up your decisions with research as to what games are big sellers.
- Need a business plan in ten days.



Isaac Sprague, Duvall, Washington

Game Theme

Determine what the time setting, object, and other themes of the game.

Make a Main Character

Come up with a main character who will progress through the game.

Develop Other Characters and Scenes

Develop your characters and scenes by producing several models and renderings in Rhino.

Game Plan

Present your game plan including character designs to your "investors" (three-page, single-spaced minimum). Present the elements above in a clear and concise manner and in such a way that the "investors" are willing to fund your project. Describe characters in as much detail as is necessary to show the themes of the game (may be in the form of character statistic sheets).

Example 10 — Automotive Accessories

Problem Statement

You have decided to start up a new automotive accessory manufacturing company. Investors will only look at your company seriously if you have between 10 and 15 types of accessories designed and if you have a specific target market selected. The investors will make a decision on whether to back your company in 15 days.

Parameters/Research

You have been given the following tasks from your investors:

- Determine a segment of society that will be your target market.
- Come up with a simple yet recognizable logo.
- Make a mission statement.
- Back up your decisions with research.
- Need a business plan including 10-15 accessory designs in 15 days.

Geofrey Oestreich, Duvall, Washington

Mission Statement

Determine what your company will do. The mission statement should tell who you are and what you intend to do. It should be short and sweet. It should use active verbs. (You might need to research what a mission statement is.)

Make a Logo

Come up with a recognizable company logo. Make sure that it does not violate anybody else's copyrighted material.

Develop Accessory Designs

Develop your accessory designs by producing several models and renderings in Rhino.

Business Plan

Present your business plan including accessory designs to your "investors" (three-page, single-spaced minimum). Include a page (not included with the page count) with the company name, mission statement, and logo. Create a one-page specification sheet for each accessory which includes what materials will be used, what vehicles it will be accessorize, and other pertinent information (not included in page count). Include rationale for target market chosen.

Example 11 — Toy Company

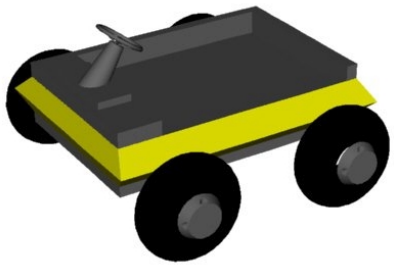
Problem Statement

You have decided to start up a new toy manufacturing company. Investors will only look at your company seriously if you have between 10 and 15 toy designs and if you have a specific target market selected. You must also decide what niche of the target market you will seek to enter (children's playground equipment). The investors will make a decision on whether to back your company in ten days.

Parameters/Research

You have been given the following tasks from your investors:

- Determine a segment of society that will be your target market.
- Determine your niche in that market.
- Come up with a simple yet recognizable logo.
- Make a mission statement.
- Back up your decisions with research.
- Need a business plan including 10-15 designs in ten days.



Shad Saindon, Duvall, Washington

Mission Statement

Determine what your company will do. The mission statement should tell who you are and what you intend to do. It should be short and sweet. It should use active verbs. (You might need to research what a mission statement is.)

Make a Logo

Come up with a recognizable company logo. Make sure that it does not violate anybody else's copyrighted material.

Develop Toy Designs

Develop your toy designs by producing several models and renderings in Rhino.

Business Plan

Present your business plan including shoe designs to your "investors" (three-page, single-spaced minimum). Include a page (not included with the page count) with the company name, mission statement, and logo. Create a one-page specification sheet for each toy design which includes what materials will be used, what assembly will be required, and other pertinent information (not included in page count). Include rationale for target market chosen.

Example 12 — Shoe Company

Problem Statement

You have decided to start up a new athletic shoe manufacturing company. Investors will only look at your company seriously if you have between five and nine shoe designs and if you have a specific target market selected. Currently, there is a great need for shoes that are relatively inexpensive, have simple lines, but have distinctive trademarks (like the Nike swoosh). The investors will make a decision on whether to back your company in ten days.

Parameters/Research

You have been given the following tasks from your investors:

- Determine a segment of society that will be your target market.
- Come up with a simple yet recognizable logo.
- Make a mission statement.
- Back up your decisions with research.
- Need a business plan including 5–9 designs in 10 days.

Mission Statement

Determine what your company will do. The mission statement should tell who you are and what you intend to do. It should be short and sweet. It should use active verbs. (You might need to research what a mission statement is.)

Make a Logo

Come up with a recognizable company logo. Make sure that it does not violate anybody else's copyrighted material.

Develop Shoe Designs

Develop your shoe designs by producing several models and renderings in Rhino.

Business Plan

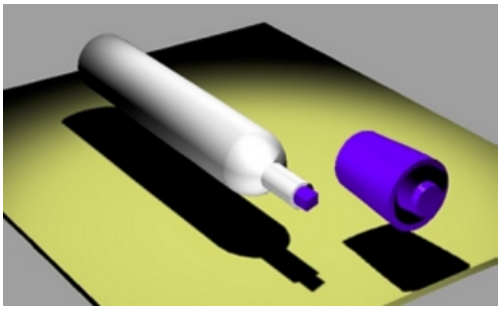
Present your business plan including shoe designs to your "investors" (three-page, single-spaced minimum). Include a page (not included with the page count) with the company name, mission statement, and logo. Create a one-page specification sheet for each shoe design which includes what materials will be used, what shoe sizes will be available, and other pertinent information (not included in page count). Include rationale for target market chosen.

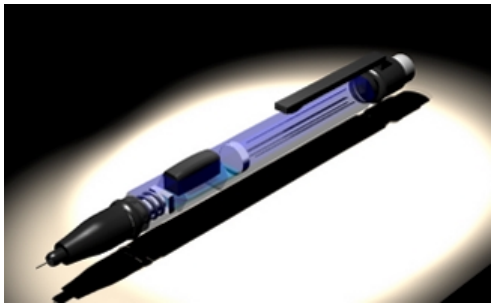
Rendering Tips

One of the most time-consuming skills students will have to learn is rendering. The process to render a model is actually quite easy. However, students will spend hours trying to get just the right color, lighting and shadows on their models. One way to teach rendering skills is to use the following lighting technique. It is quick and easy and allows them to understand the basics of how Rhino renders a scene.

1. Draw a large rectangular surface in the top viewport.
2. Move the model just above the flat surface so it appears to float over it.
3. Draw a spotlight so it shines from above, down to the object and onto the flat surface
4. Make the background color black, the ambient color gray (default), and the spotlight white. Give the flat surface a color other than black or dark gray.
5. Render in the Perspective viewport rotating the scene so you see it slightly from the top.

Examples of the Basic Lighting Technique





Additional Rendering Tips and Hints

1. Have students play around with the placement of the spotlight, using the Rotate command. Also have them use different color schemes for the spotlight and the flat surface. Eventually, they will get the hang of it and know what the appropriate colors should be and the placement of the spotlight.
2. You cannot shine a spotlight through a transparent object. The object goes black. So, for example, if you have a flashlight and you shine a spotlight from behind the lens outward, the lens will go dark. The only way around it is to shine the spotlight on the lens from the outside so it looks like that light is coming out from the lens.
3. Most of the objects in Rhino will have a flat, plastic look. The Texture option can give objects a different look and feel. Have students create a texture file in a paint program. Start them off with making a picture that has three colored stripes. Save it as a BMP or JPG file. Insert that texture file name in the Texture dialog box when they use the Render command. Students can create metal, wood, fabric or stone surfaces by importing a picture file that has an image of that surface.

Sample Fifteen-Week Syllabus

In this section we will combine both technical proficiency and technical adequacy to produce a well-rounded 3-D instructional program covering 15 weeks of instruction. At the end of this 15-week program, students will be proficient in using the Rhino software and will be able to break down images into three-dimensional designs.

The following sample course curriculum is based on using the *Rhinoceros Level 1 Training Manual* as a textbook. The instructor lecture information is based on the *Rhinoceros User's Guide* and information from the Rhino Help file.

In this section you will find a sample:

- Week by week break down for instructors
- Main points covered
- Lecture information
- Homework sheets
- Worksheets
- Notebook
- Quizzes
- Midterm exam
- Final exam
- Additional project ideas
- Grading information

Course Description

This course is concerned with the visualization and creation of 3-D computer-generated models and their applications in today's manufacturing, communication, and publishing industries.

Students will be instructed in the principles of 3-D modeling using Rhinoceros NURBS modeling software. In a laboratory setting, students will have an opportunity to practice the strategies and methods commonly used in creating and solving 2-D and 3-D geometric problems. Information given in lectures and demonstrations will address aspects of modeling free-form curves, surfaces, and solids. Students will be introduced to a variety of 3-D model applications as they are used in illustration, engineering, design, documentation drawing, entertainment, and animation.

In addition to developing a working knowledge of 3-D terminology and concepts, each student will learn how to create a variety of 3-D geometric models from technical drawings, sketches, real models, and written descriptions.

Course Objectives

This course will:

- Provide a working foundation in sketching, interpreting, and creating computer-generated models.
- Provide students with the ability to describe the organization, terminology, function, capabilities, and limitations of 3-D computer graphic software in regards to modeling.
- Use Rhino 3-D modeling software to create surface and solid models.
- Set up a 3-D scene and view 3-D space.

- Develop sketches of models and practice viewpoint identification and selection.
- Place lights and render scenes.

Textbooks and Materials

- *Rhinoceros Level 1 Training Manual l.*
- 2 - 11" x 14" black presentation boards
- 1 PC formatted zip disk
- Sketch pad (this does not have to be new)
- Pencils
- Ruler
- 3-ring binder with plastic pages to keep projects in.
- Graph paper at least 1/4"

Grading

Homework Sheets 40%

Completing assigned homework on time is essential to learning computer software. Students must be encouraged to keep up with the daily computer work so future projects can be completed. Students who fall behind in assignments in the first few weeks of class find it difficult to produce more complicated designs near the end of the semester.

Worksheets and Quizzes 20%

Worksheets are used to teach the basic vocabulary of the software program. Learning the terminology of a software program lets a student use the correct term when asking a question or contributing to a class discussion. Filling out worksheets gives students a written guide for studying quiz, midterm, and final test material. Quizzes require students to commit to memory the vocabulary used in the software program and the general commands for navigating around the software.

Midterm 5%

The midterm is the halfway point in the semester. The midterm gives both the instructor and the student the opportunity to look at the progress the student has made so far. This is a good time for the instructor to evaluate the pace of the class and make any necessary changes in the curriculum.

Student Notebook 10%

A required student notebook is one way for instructors to teach students the importance of keeping all of their work together. Students should keep a notebook containing their projects for the entire semester. For the instructor this is a good way to see the improvement in the progress of the student over a period of time. For the student, the notebook is a valuable source of reference for future design projects.

Students are required to keep all handouts, sketches, photographs, computer printouts, projects, and any other information that pertains to the class in the notebook. The notebook is collected on week fourteen of class, graded, and handed back on the final day.

Final Project 15%

The final project is the students' chance to show off the work they have put into learning the software and design elements over the semester. Although students are given final project guidelines to follow, encourage them to be inventive and creative. The final project should be a major portfolio piece when completed.

Final 10%

The final is a cumulative collection of information given over the course of the semester. The final covers vocabulary and a computer modeling section. By the end of the semester, students should be able to re-create simple computer models without detailed instruction.

Sample Week-by-Week Lesson Plans

Overview

Week 1	**Lecture** The basics: introduction to Rhino, just what in the heck is meant by "NURBS"? An overview of the basic Rhino menu. Saving and printing. **Class Work** Exercise 1, our first look. Free time to explore on own. **Homework** Read pages 1 through 54. Do exercises 1 through 15. **On Your Own** See homework handout for week 1. **Worksheet** Due following week.
Week 2	**Lecture** Coordinates, x, y, and z. Absolute coordinates vs. relative coordinates. Distance constraints and angle constraints including ortho, elevator and planar mode. Bitmaps. **Class Work** Exercise 17, practice using distance and angle constraints. **Homework** Read pages 55 through 98. Do Exercises 16 through 24. **On Your Own** See homework sheet for week 2. **Worksheet** Due following week.

Week 3	**Lecture** The art of rendering. Bringing in outside textures. Building a shadow room. Spotlights. **Class Work** Show and tell class discussion. Making textures and applying them to objects. Lighting objects. **Homework** Read pages 99 through 168. Do exercises 25 through 43. **On Your Own** See homework sheet for week 3. **Worksheet** Due following week. Study for quiz.
Week 4	**1st Quiz** **Lecture** The five fundamental geometric objects in Rhino. Points, curves, surfaces, polysurfaces and solids. Point editing. **Class Work** Show and tell class discussion. Exercise 47 Creating and rebuilding surfaces. Blending two objects. **Homework** Read pages 173 through 218. Do exercises 48 and 49. **On Your Own** See homework sheet for week 4. **Worksheet** Due following week.

Week 5	**Lecture** Text in Rhino. How to make a screen capture. Review for midterm exam. **Class Work** Show and tell class discussion. Working with text. Doing a screen capture. **Homework** Read pages 219 through 265, modeling with solids. **On Your Own** See homework sheet for week 5. **Worksheet** Study for midterm exam.
Week 6	**Midterm Exam** **Lecture** None. **Class Work** Show and tell class discussion. Continue to work on assignment 5. **Homework** Continue with project. **On Your Own** See homework sheet for week 6. **Worksheet** Due following week.

Week 7	**Lecture** Sweeps and Rails. **Class Work** Show and tell class discussion. Continue group work on project 6. **Homework** Read pages 325 through 354. Do exercises 61 and 62. **On Your Own** See homework sheet for week 7. **Worksheet** Due following week.
Week 8	**Lecture** Design elements for electronic page layout. **Class Work** Show and tell class discussion. Work on projects. **Homework** Read pages 296 through 324. Do exercise 60. **On Your Own** See homework sheet for week 8. **Worksheet** None.
Week 9	**Lecture** Customizing workspaces and toolbars. **Class Work** Show and tell class discussion. Work on projects. **Homework** Read pages 395 through 405. Do exercise 68. **On Your Own** Continue to work on your arts magazine cover. **Worksheet** Study for quiz 2.

Week 10	**2nd Quiz** **Lecture** Final project. Option 1 for the art designer. Option 2 for the technical designer. **Class Work** Show and tell class discussion. Work on projects. **Homework** Read pages 355 through 391. Do exercises 63, 64, and 65. **On Your Own** See homework sheet for week 10. **Work sheet** None.
Weeks 11, 12, and 13	**Class Work** Group work.
Week 14	**Lecture** Review for final. All projects are due. Final notebook is due. **On Your Own** Study for final.
Week 15	**Final Exam**

Lesson Plan 1

Overview

Lecture	Manual	Vocabulary
Introduction NURBS Basic Menu Saving Printing	Rhino Basics Viewports Navigating Moving objects Copy objects Drawing lines Drawing free-form curves Options Saving Layers Deleting Undo and Redo Coordinates	Ortho Grid Snap Planar Absolute coordinates Relative coordinates Polar coordinates Distance constraint Angle constraint Command line Status bar Flyout toolbar Line Polyline Tangent

Lecture

Introduction to Rhino

An introduction to Rhino can be found in the *Rhinoceros User's Guide,* Chapter 1, "Introduction," starting on page 13.

Just what in the heck are NURBS?

A section on NURBS geometry can be found in the *Rhinoceros User's Guide,* Chapter 28, "About NURBS," starting on page 447.

Overview of the basic menu.

A basic layout of Rhino's screen can be found on pages 7 through 11 of the *Rhinoceros Level 1 Training Manual*.

Saving and printing.

Save and print can both be found under the Rhino Help file in the program. The Rhino Help file will be a valuable resource of information and handouts for you and your class.

Notebook

Students are required to keep all handouts, sketches, photographs, computer printouts, projects and any other information that pertains to the class in the notebook. The notebook is collected on week fourteen of class, graded and handed back on the final day.

Class Work

Exercise 1 on page 14 of the *Rhinoceros Level 1 Training Manual*.

Free time to explore on own.

Homework

Read pages 3 through 54.

Do exercises 1 through 15.

Try On Your Own, page 28.

Build a three dimensional model of your own design. Use shapes from exercise 1. Print four viewports and hand in.

Exercise 15, page 53.

Follow the instructions in the manual. On graph paper redraw the arrow shape and write in the x,y coordinates. Print four viewports and hand in the exercise with the graph paper.

Worksheet

Complete worksheet, due the following week. See sample worksheet in section one.

Student Notebook

A required student notebook is one way for instructors to teach students the importance of keeping all of their work together. Students should keep the notebook containing their projects for the entire semester. This is a good way for the instructor to see the improvement in the progress of the student over a period of time. The notebook is a valuable source of reference for future design projects for the student.

Worksheet 1

Define the following Rhino terms:

1. Viewports:

2. Command line:

3. Status bar:

4 Flyout toolbar:

5. Grid:

Answer the following questions:

1. How do you pan and rotate in viewports?

2. How do you zoom in and out in viewports?

3. What are the three options for entering in Rhino?

4. How do you cancel a command?

5. What is the command line history, what is it used for, how do you access it?

6. What is the difference between a line and a polyline?

7. If you click on the Curve: interpolated points button, what kind of object is drawn?

8. While in the interpolated curve command, what happens when you type the C option? When you type the U option?

9. What is ortho? What is the default angle? What would you draw with ortho on?

10. Why would a grid come in handy, and what is its function key?

11. What is snap? What is the command key? Where else can you turn snap on and off?

12. What are absolute coordinates?

13. What are relative coordinates?

14. What are polar coordinates?

Sample Answer Sheet 1

Define the following Rhino terms:

1. Viewports:

   Displays different views of the model within the graphics area.

2. Command line:

   Lists commands you enter and information produced.

3. Status bar:

   Displays the coordinates of the pointer, the status of the model, options, and toggles.

4. Flyout toolbars: Sub-toolbar that includes options. Buttons that have flyout toolbars are marked with a small white triangle in the lower corner.

5. Grid: Reference on construction plane used for building precise models.

Answer the following questions:

1. How do you pan and rotate in viewports?

   Drag with the right mouse button. Pans in parallel projection viewports; rotates in perspective projection viewports.

2. How do you zoom in and out in viewports?

   Hold the CTRL key and drag with the right mouse button or use the mouse wheel.

3. What are the two substitutes for pressing the Enter key in Rhino?

   Spacebar or right mouse button.

4. How do you cancel a command?

   Press the Esc key or select a new command from a button or menu.

5. What is the command line history, what is it used for, how do you access it?

   It lists the 500 command lines from the current Rhino session. It is used so you can view the last actions you made in the program. Access it by pressing F2.

6. What is the difference between a line and a polyline?

   Line draws a single line segment end to end. A polyline draws a line with multiple vertices, multiple segments.

7. If you click on the Curve: interpolated points button, what kind of object is drawn?

   An interpolated point draws a curve through the points you pick.

8. While in the interpolated curve command, what happens when you type the option C? When you type the option U?

   C closes the shape. U undoes the last command.

9. What is ortho? What is the default angle? What would you draw with ortho on?

   Ortho restricts cursor movement to a specified angle from the last point created. The default angle is 90 degrees. You would draw something like a box.

10. Why would a grid come in handy, and what is its function key?

    It would help you line up objects. Function key F7.

11. What is snap, what is the command key, where else can you turn snap on and off?

    Snap forces the pointer to snap on grid intersections. The command key is S. It is also found in the status bar on the bottom of the page.

12. What are absolute coordinates?

    Absolute coordinates are the exact locations on the x, y, z, axes.

13. What are relative coordinates?

    Relative coordinates are based on the last point instead of the 0,0 coordinates.

14. What are polar coordinates?

    Polar coordinates specify a point that is a distance and direction away from 0,0 in the current construction plane. Four units away at a 45-degree angle clockwise = 4<45.

Homework 1

Read *Rhinoceros Level 1 Training Manual* pages 3 through 54.

Do exercises 1 through 15.

To hand in:

"Try On Your Own," page 28.

Using shapes from exercise 1, build a three-dimensional model of your own.

Print four viewports and a rendered version.

Exercise 15—Practice, page 53.

Follow the instructions in the manual.

On graph paper redraw the arrow shape and write in the x,y coordinates.

Print four viewports and hand in the exercise with the graph paper.

Lesson Plan 2

Overview

Lecture	Manual	Vocabulary
Coordinates Constraints Bitmaps	Construction planes Elevator mode Object snaps Analysis commands Drawing circles Drawing arcs Drawing ellipses and polygons	Construction plane Elevator mode Tangent Quadrant Hexagon Octagon Triangle Rectangle Ellipse Circumscribed Perpendicular Parabola Hyperbola

Lecture

Coordinates, x, y, and z

Absolute coordinates and relative coordinates, Cartesian, and polar coordinates.

A discussion of coordinates can be found in the *Rhinoceros User's Guide,* Chapter 11, "Enter Coordinates," starting on page 167. More information can be found in the Rhino Help file.

Distance and angle constraints including ortho, elevator and planar mode

A discussion of constraints can be found in the *Rhinoceros User's Guide,* Chapter 12, "Constrain Cursor Movement," starting on page 177 and in the Rhino Help file.

Bitmaps

Tracing bitmap information can be found in *Rhinoceros User's Guide,* Chapter 26, "Trace Bitmaps," starting on page 429 and in the Rhino Help file.

Class Work

Exercise 17, Practice using distance and angle constraints.

Homework

Read pages 55 through 98.

Do exercises 16 through 24.

Exercises 20, 23 and 24 graph with coordinates. Print four viewports and rendered versions.

Exercise 18 print the top viewport and write the analysis results on the print out for the different shapes.

Exercise 21 and 22, print four viewports, do not graph.

On Your Own

See homework sample for Rhino week two.

Worksheet

Complete worksheet, due the following week. See sample worksheet in section two.

Worksheet 2

Define the following Rhino terms:

1. Elevator mode:

2. Object snaps:

3. Analysis commands:

4. Circumscribed:

5. Perpendicular:

Answer the following questions:

1. Where do you find object snaps (osnap)? Describe the function of some of the osnaps.

2. Where you would go to find the angle between two lines?

3. How do you measure the radius of a circle?

4. Discuss the various circle creation commands? What would be a good situation for using each?

5. What is one way you can make a drawing 3-D?

6. Discuss the various arc creation commands? What would be a good situation for using each?

7. What happens when you draw a polygon with the PolygonEdge command?

8. While using the ellipse command, what happens when you use the V option?

9. What is a parabola?

10. What is a hyperbola?

11. What do you type to undo your last move or point?

12. How do you close a curve to its start point?

13. What is angle constraint, and what is it used for?

14. What is distance constraint, and what is it used for?

15. How do you use distance and angle constraint together?

Homework 2

Read pages 55 through 98.

Do exercises 16 through 24.

To hand in:

Exercise 20, 23, and 24. Print four viewports; print a rendered version and then graph with coordinates.

Exercise 18, print top the viewport and write the analysis results on the print out for the different shapes.

Exercise 21 and 22, print four viewports, do not graph.

On your own

Find a picture of an object you can trace around in Rhino. Scan this picture and save the file as a JPG.

In Rhino, start a new model.

Place the bitmap (View > Background Bitmap > Place) in the top viewport.

For the information on how to place, resize, and move the bitmap image, see the Rhino Help file and for information on background bitmaps.

Trace around this image and extrude it. Use what you have learned to make this traced image into a 3-D image.

Lesson Plan 3

Overview

Lecture	Manual	Vocabulary
Rendering Textures Spotlights	Modeling Freeform Curves Changing the viewport display Editing objects Move objects Copy Rotate Mirror Join Scale Array rectangular Array polar Offset Trim Split Extend	Curve Interpolated curve Sketch curve Helix Spiral Conic Parabola Hyperbola Fillet Loft Chamfer Join Scale Array Polar array Offset Trim Split Extend

Lecture

The Art of Rendering

Rendering information can be found in *Rhinoceros User's Guide*, Chapter 25, "Render," starting on page 413. Additional information on rendering and spotlights can be found in the Rhino Help file. See the section "Rendering Tips" on page 24 in this guide.

Bringing in outside textures

Building a shadow room

Spotlights

Class Work

Show and tell class discussion.

Making textures and applying them to objects.

Lighting objects.

Homework

Read pages 99 through 168.

Do exercises 25 through 43.

Exercise 31, graph with coordinates, print four viewports and a rendered version.

Exercises 26, 33, 38, 39, 43, print four viewports and a rendered version.

On Your Own

See homework sample for Rhino week 3.

Worksheet

Complete worksheet, due the following week. See sample worksheet in section three.

Study for quiz. A sample quiz can be found in the Appendix of this instructor's guide.

Worksheet 3

Define the following Rhino terms:

1. Fillet:
2. Chamfer:
3. Mirror:
4. Join:
5. Scale:
6. Array:
7. Offset:
8. Split:
9. Extend:
10. Helix:

Answer the following questions:

1 What does the Radius option do in the Fillet command?

2 What does the Join option do in the Fillet command?

3 What is the difference between a rectangular array and a polar array?

4 When you are using the Rotate command, in what direction do positive numbers rotate? Negative numbers rotate?

5 In Array Rectangular, what is the meaning of the following: Number in x-direction, number in y-direction , number in z-direction, unit cell or x-spacing, y-spacing (show examples).

Homework 3

Read pages 99 through 168.

Do exercises 25 through 43.

Graph with coordinates the following exercise: Exercise 31. Print four viewports and a rendered version.

Exercise 26, 33, 38, 39, and 43. Print four viewports and a rendered version.

Study for quiz.

On Your Own

Problem Statement

You have been given a box of odd-sized wheels by *Wheelcan*, a wheel manufacturing company. *Wheelcan* will give a prize to the person who comes up with the most innovative way to use these wheels.

Parameters

- The design has to be functional.
- Use more than one size of wheel.
- It does not have to be an even number of wheels.

Brainstorm

Draw ten thumbnails of objects that incorporate the use of different size wheels.

Select Best One

Select your best design, be ready to back up your decision.

Develop Your Idea

Produce a model file and a rendered version in Rhino.

Test/Evaluate

Evaluate your wheel design against the parameters, make changes if necessary.

Presentation

Put your object on a plane. See Rhino Help file for more information. Use spotlights to cast a shadow on your object. Render in color. You may add textures if you choose. Present your wheel design to the class.

Turn in thumbnails and project

Sample Design Activities can be found starting on page 9 of this guide.

Lesson Plan 4

Overview

Lecture	Manual	Vocabulary
The Five Fundamental Geometric Objects in Rhino. Points, Curves, Surfaces, Polysurfaces and Solids. Point Editing	Control Point Editing Creating Deformable Shapes Splitting Surfaces Blending Surfaces Rendering Spotlights	NURBS Control points Degree Knots Edit points Points Curves Surfaces Polysurfaces Solids

Lecture

The Five Fundamental Geometric Objects in Rhino

Points, curves, surfaces, polysurfaces, and solids.

Lecture information for the five fundamental geometric objects in rhino can be found in the *Rhinoceros User's Guide,* Chapter 16, "Rhino Geometry," starting on page 237. Additional information can be found in the Rhino Help file.

Point Editing

Point editing information can be found in the *Rhinoceros User's Guide,* Chapter 20, "Edit with Control Points," starting on page 301.

Class Work

Show and tell class discussion.

Exercise 47, creating and rebuilding surfaces.

Blending two objects.

Homework

Read pages 173 through 218.

Do exercises 48 and 49.

Exercise 48. Create your own set of glasses. Add texture and lighting. Print four viewports and a rendered version.

Exercise 49. Use spotlights to create shadows. Set ducky on a surface plane. Print four viewports and a rendered version.

On Your Own

See homework sample for Rhino week four.

Worksheet

Complete worksheet, due the following week. See sample worksheet in section four.

Worksheet 4

Define the following Rhino terms:

1. NURBS:
2. Control points:
3. Degree:
4. Knots:
5. Edit points:

Answer the following questions:

1. Why it is important to have the option to be able to edit the control points when working on an object in Rhino?
2. What are two ways to turn on and off the control points?
3. How do you change polylines into curves without kinks?
4. Can a degree-3 curve have kinks?
5. What happens when you loft a surface over curves?
6. What are the two basic ways to model in Rhino?
7. Explain why or when you would use the two different ways in question 6.
8. In the object properties box, what effect does highlight have on your finished model?
9. In the object properties box, what effect will sliding the transparency bar to transparent have on your finished model?
10. What are the five geometric objects in Rhino, and which of these can you use control points to edit?

Homework 4

Read pages 173 through 218.

Do exercise 48 and 49.

Exercise 48, Free-form glass. Create your own set of glasses. Print four viewports and a rendered version..

Exercise 49, Ducky. Create shadows. Print four viewports and a rendered version.

On Your Own

Problem Statement

Using what you have learned about creating a bird in project 49, design your own bird. It can be a real representation or an imagery representation of a bird.

Parameters

- The bird has to have at least one blended neck.
- You may add texture to your bird.
- Your finished bird has to be in some kind of environment.
- The entire bird must be drawn in Rhino.

Brainstorm

Draw five thumbnails of birds.

Select Best One

Select your best design.

Develop Your Idea

Produce a model file and a rendered version in Rhino.

Test/Evaluate

Evaluate your bird design against the parameters. Make changes if necessary.

Presentation

Put your bird in an environment. Use spotlights to cast a shadow on your bird. Render in color. You may add textures if you choose. Present your bird to the class.

Turn in thumbnails and project.

Sample Design Activities can be found starting on page 9 of this guide.

Lesson Plan 5

Overview

Lecture	Manual	Vocabulary
Text Screen capture	Modeling Solids Text	Extrude surface Cap planar holes Boolean union Boolean difference Boolean intersection

Lecture

Text in Rhino

Information on text can be found in the Rhino Help file.

How to make a screen capture

Have the student open the model in Rhino they want to capture. To capture a single viewport, use the ScreenCapturetoClipboard or ScreenCapturetoFile commands. To capture the entire Rhino window, press the Print Scrn button on the keyboard. Paste or insert the image into another program like PhotoShop or Power Point.

Review for Midterm

Class Work

Show and tell class discussion.

Working with text.

Making a screen capture.

Homework

Read pages 219 through 265. Modeling with Solids.

Do exercise 50. Print four viewports and a rendered version.

On Your Own

See homework sample for Rhino week 5.

Worksheet

Study for midterm exam.

Homework 5

Read pages 219 through 265.

Do exercise 50. Print out a rendered version and print out in 4 viewports.

Study for Midterm exam.

Cement the basics.

On Your Own

Problem Statement

Use what you have learned so far in this first section of the semester. Create an exercise of your own, just like the exercises in the manual. You may need to add some definitions for the actions or commands you use.

Parameters

The exercise you create should have some complexity to it.

No simple one-shaped objects.

You will be graded on creativity, originality, and complexity.

One of your fellow classmates must be able to follow your instructions and complete the project successfully.

Brainstorm

Draw ten thumbnails of items you would like to design in Rhino.

Select Best One

The class will select the best design.

Develop Your Idea

Produce a model file and a rendered version in Rhino.

Test/Evaluate

You will have to keep an accurate track of your steps. Write down every step you make as you make it, and then later try to follow your instructions. ***Notice! Don't leave out any steps thinking the other person who gets your exercise will know what to do next! Don't assume anything.***

Presentation

You may want to add some screen captures or other visuals along the way. Use the layout in the manual as an example of how your exercise should look. The tutorial section of this assignment should be done in a page layout program. You may use Word, PageMaker, or Quark. A fellow classmate will receive your project to evaluate. The corrected final project will be included in a class project book.

Turn in thumbnails and project with full written instructions.

Sample Design Activities can be found starting on page 9 of this guide.

Lesson Plan 6

Overview

Lecture	Manual	Vocabulary
Midterm	None	No new vocabulary

Lecture

Midterm Exam

In Class Work

Show and tell class discussion.

Continue to work on assignment 5.

Homework

Continue with project

On Your Own

See homework sample for Rhino week six.

Worksheet

Complete worksheet, due the following week. See sample worksheet in Section 6.

Worksheet 6

Define the following Rhino terms:

1. Extrude Surface:
2. Cap Planar Holes:
3. Boolean Union:
4. Boolean Difference:
5. Boolean Intersect:

Answer the following questions:

1. True or False: You would use Cap Planar Holes to close simple holes in a surface or a partial solid.
2. True or False: Extrude Surface creates a solid by extruding a surface horizontally.
3. What is Boolean Difference used for?
4. What is Boolean Union used for?
5. What is Boolean Intersect used for?
6. True or False: An Ellipsoid would be a good choice if you were designing an Easter egg. This is a trick question. Are ellipsoids really "egg-shaped"? What would be a good method of creating a real egg-shape?
7. When applying a Boolean Difference to a model, which do you select first: the main item or the item you want to subtract?
8. Why is it a good idea to render an object before you copy and place it in other areas of the design? (give two reasons)
9. What is the fastest and easiest way to arrange the same object multiple times in a circle?
10. What are the five geometric objects in Rhino, and which of these can you use control points to edit?

Homework 6

Exercise Reconstruction

On Your Own

Problem Statement

Now that you have created an exercise on your own you can see how tricky it can be. This week you will take the exercise created by one of your classmates and following their instructions to complete the project.

Parameters

- Check closely for errors.
- Make corrections if it is necessary and write them down.
- Go over the project with the designer to discuss any changes that may need to be made.
- A correct and professional exercise is expected when completed.

Test/Evaluate

Make sure all steps are correct and explained in a matter that will make them easy to follow.

Presentation

The project designer will present the final project to the class.

Turn in corrected project with full written instructions.

Lesson Plan 7

Overview

Lecture	Manual	Vocabulary
Sweeps and Rails	Creating Surfaces Extruding Surfaces Lofted Surfaces Sweep Surfaces Path Curve Helix	Surface Patch Revolve Sweep 1 Sweep 2 Fillet Edge Fillet Surface Blend Surface Rail Revolve Extrude Plane

Lecture

Sweeps and Rails.

Lecture information on sweeps and rails can be found in the *Rhinoceros User's Guide*, Chapter 18, "Create Surfaces," starting on page 265. Additional information can be found in the Rhino Help file.

Class Work

Show and tell class discussion.

Continue group work on project 6.

Homework

Read pages 325 through 354.

Do exercise 61, page 325 and exercise 62, page 346.

Hand in the image of the squeeze bottle from page 345. Print four viewports and a rendered version.

On Your Own

See homework sample for week 7.

Worksheet

Complete worksheet, due the following week. See sample worksheet in section seven.

Note: This is the last scheduled worksheet for the semester.

Worksheet 7

Define the following Rhino Commands:

1. Patch:
2. Sweep 1:
3. Sweep 2:
4. Fillet Edge:
5. Rail Revolve:
6. Plane:
7. Extrude:
8. Loft:
9. Revolve:
10. Blend Surface:

Answer the following questions:

1. If you wanted to put a smooth end cap on an irregularly shaped surface what command would you use?
2. True or False? Surfaces have area, but their shape can not be changed by moving control points, and they can not be meshed.
3. True or False? Loft creates a surface from shape curves. The normal option makes a surface with creases as it passes over the shape curves.
4. To visualize surface shape, Rhino displays a grid of isoparms on the surface. What are isoparms?
5. True or False: A Rhino surface is similar to a piece of cloth, but it cannot be stretched.

Homework 7

Read pages 325 through 354.

Do exercises 61 and 62. Hand in the image of the squeeze bottle. Print four viewports and a rendered version.

In class work on the manual exercise you created and put it into a standard format so we can finish our book.

On Your Own

Problem Statement

After you have completed the table in exercise 62, create four lawn type chairs to go with it. Put your lawn table and chairs in an outside environment. Make your table and chairs look like an ad for a discount store. Check the newspaper ads for examples.

Parameters

- Your ad should have text and pricing.
- It should be sized to fit as a newspaper ad.
- You may use additional software.

Brainstorm

Draw five lawn furniture layouts and include text.

Select Best One

Select the ad that has the best over all design.

Develop Your Idea

Produce a model file and a rendered version in Rhino. Import the Rhino image into a page layout program.

Test/Evaluate

Have someone else check your final layout for leading, kerning and spelling problems. Look at the over all design of your ad. Is this an ad a store would buy to advertise their product?

Presentation

Mount your advertisement on an 11 x 14 black presentation board.

Turn in thumbnails and project.

Sample Design Activities can be found starting on page 9 of this guide.

Lesson Plan 8

Overview

Lecture	Manual	Vocabulary
Design Elements	Surface creation techniques	Contrast Repetition Alignment Proximity Leading Kerning Point Pica Balance Eye-track

Lecture

Design Elements for Electronic Page Layout.

Material for this lecture came from outside design sources. A good source of information for instructors who are not graphic designers is *The Non-Designer's Design Book: Design and Typographic Principles for the Visual Novice*, by Robin Williams.

.

Class Work

Show and tell class discussion.

Work on projects.

Homework

Read pages 296 through 324.

Do exercise 60, creating a toy hammer. Print four viewports and a rendered version.

On Your Own

See homework sample for Rhino week eight.

Create a template for the student's to use when laying out their magazine page. This template should be stored in a folder on the shared system so students could access it.

Board Critique

A board critique is used to give students experience explaining their projects in front of a group. The student mounts his or her project on a specified size and color of board. This board is then set up on an easel for display during the student's time to explain and show their project.

Homework 8

Read pages 296 through 324.

Do exercise 60, creating a toy hammer. Print four viewports and a rendered version.

On Your Own

Problem Statement

You are employed at *Arts* magazine. You have been chosen to layout the cover for the next issue. A brand new software program named Rhinoceros has just been released on the market. Your assignment is to create the cover of *Arts* magazine advertising the new Rhino program. Rhino will be your main cover story. Keep in mind that there will also be other items in this issue. I suggest you take a look at a stack of *Arts* magazines to see how past issues are laid out. You have a two-week deadline for this cover. This is a portfolio piece, so grading will be stiff. The final copy will be printed in color. To save yourself some money, I suggest you print the proof in b/w. You may use whatever software you choose along with Rhino to create your desired effects. As your art director, I will be very picky. Every element will have to be right on. Be as creative as I know you can be! Good luck!

Parameters

- The final layout for this issue will be done in PageMaker.
- Use the template provided for this project found in the scan folder under Arts project.
- Remember that a magazine has to be eye catching so people will pick it off the shelf. It's the cover that sells the magazine just as much as the information inside.
- Keep in mind the elements of design (CRAP: contrast, repetition, alignment, and proximity).

Brainstorm

Draw three magazine cover layouts you would like to design for Rhino.

Select Best One

Select the layout that uses the best combination of design elements.

Develop Your Idea

Produce a model file and a rendered version in Rhino. Produce a page layout in PageMaker.

Test/Evaluate

Have someone else check your final layout for leading, kerning and spelling problems. Look at the over all design of your magazine. Is it believable? Will it fit into a stack of Arts magazines?

Presentation

Have your color printout of the magazine cover mounted on 11" x 14" presentation board and ready for a critique. (Due in two weeks.)

Turn in thumbnails.

Sample Design Activities can be found starting on page 9 of this guide.

Lesson Plan 9

Overview

Lecture	Manual	Vocabulary
Rhino Options Custom Toolbar Layouts	Practice changing options Customizing a toolbar	No new vocabulary

Lecture

Customizing Workspaces and Toolbars.

Lecture information on customizing your workspace can be found in the *Rhinoceros Level 1 Training Manual*, Part Four: "Customizing Workspaces and Toolbars," starting on page 393.

Class Work

Show and tell class discussion.

Work on projects.

Homework

Read pages 395 through 405.

Do exercise 68 on page 395, practice changing options.

On Your Own

Continue to work on your *Arts* magazine cover.

Worksheet

Study for quiz.

Homework 9

Read pages 395 through 405.

Do exercise 68, practice changing options.

Study for quiz.

On Your Own

Work on your *Arts* magazine project, due at the beginning of class next week.

Your project should be mounted on 11" x 14" black presentation board.

Lesson Plan 10

Overview

Lecture	Manual	Vocabulary
Final project Art designer Technical designer	Importing and exporting models Creating mesh objects 2-D into 3-D Rendering Printing	Polygon mesh Mesh from NURBS object Object properties

Lecture

Final Project

Option 1 for the art designer

Option 2 for the technical designer

Final projects are divided into two categories. One project for the art-minded student and another project for the technical-minded student. This lets the student choose which project he or she is more suited for.

Class Work

Show and tell class discussion.

Work on projects.

Homework

Read pages 355 through 391.

Do Exercises 63, 64 and 65.

Be able to explain to the class, which program you chose to import into and show how you imported your file.

On Your Own

See homework sample for week 10.

Homework 10

Read pages 355 through 391.

Do exercises 63, 64, and 65.

Go through *Rhinoceros Level 1 Training Manual*, Chapter 11, "Importing and Exporting Models" starting on page 355. Follow the instructions, and then try to take your table into AutoCAD and 3D Studio MAX. Print out your imports and write a brief explanation.

On your own

Problem Statement

The hottest new Water Park in the state has hired you as a freelance designer. It is your challenge to come up with new, fun ideas for activities that include water. Theses activities could include new slide designs, water boats, or rides that involve water. Use your imagination.

Parameters

- The design must include the use of water.
- Cost is not a concern but the amount of space the design incorporates is important.
- The design should be age rated.
- Take into account safety concerns.

Brainstorm

Design ten rough sketch ideas to show to the client.

Select Best One

The class will select the two best designs.

Develop Your Idea

Produce two model files and rendered versions in Rhino.

Test/Evaluate

Check your designs against the design parameters.

Presentation

Write up as much information about your projects as you can. For example, the size of the structure, age restrictions, safety concerns and so on.

Turn in thumbnails and projects with written presentations.

Sample Design Activities can be found starting on page 9 of this guide.

Lesson Plan 11, 12, and 13

Overview

Lecture	Manual	Vocabulary
Group Work	Use for reference	No new vocabulary

Lecture

At this point in the semester, student's should be able to work either in groups or on their own to complete special projects that are of interest to them and to work on their portfolio's.

Students should be assigned outside reading material on 3-D that can be found in many of the more current magazines at major bookstores. This helps students broaden their horizons and gives them an opportunity to see what other designers are working on. Students will often bring back information to share with the class. Students are encouraged to share any interesting outside information they find with the class and this often leads to enlightening group discussions.

Encourage creativity and independent thinking. This is an opportunity to spend more time on design concepts. Push your students to improve the quality of their work. Communication between student's and the instructor is very important when allowing student's to work on there own. Talk to each student about their project.

On Your Own

Final projects begin.

Homework 11

On your own

Final projects begin.

See final project handout sheets.

Homework 12

On your own

Work on final projects and portfolio work.

Homework 13

On your own

Work on final projects and portfolio work.

Next week all projects and final notebook are due.

Lesson Plan 14

Overview

Lecture	Manual	Vocabulary
Review for Final	Use for reference	No new vocabulary

Lecture

Review for final.

See sample final. Information for the final was taken from the worksheets and lecture information.

All projects are due.

Final notebook is due.

On Your Own

Study for final.

Homework 14

Pre-finals week, study for final.

All projects are due.

Final notebook is due.

Lesson Plan 15

Overview

Lecture	Manual	Vocabulary
Final Exam	Use for reference	No new vocabulary

Final Exam

Appendix:
Sample Tests

Rhino Quiz #1

Define the following Rhino terms and describe what each action is used for.

1. Fillet:

2. Chamfer:

3. Mirror:

4. Split:

5. Extend:

6. Elevator mode:

7. Object snaps:

8. Analysis commands:

9. Circumscribed:

10. Join:

11. Scale:

12. Array:

13. Offset:

14. Perpendicular:

15. Viewports:

16. Command line:

17. Status bar:

18. Flyout toolbar:

19. Ortho:

Rhino Quiz #1 — Instructor's Copy

Define the following Rhino terms and describe what each action is used for.

1. **Fillet:**

   Connects two lines, arcs, or curves extending or trimming them to intersect or to join with a circular arc.

2. **Chamfer:**

   Connects two curves by extending or trimming them to intersect or to join with a beveled line. Chamfer works on convergent or intersecting lines.

3. **Mirror:**

   Creates a copy of the objects flipped over a specified axis on the construction plane.

4. **Split:**

   Splits one object with another, or a curve at a point. Split breaks the object where it intersects of the cutting object, but does not delete anything.

5. **Extend:**

   Extend lengthens an object to make it end precisely at its intersection with another object or you can lengthen an object when there is no intersection.

6. **Elevator mode:**

   Lets you pick points that are off the construction plane. Elevator mode requires two points to completely define the point.

7. **Object snaps:**

   Tools for selecting specific points on existing objects.

8. **Analysis commands:**

   Are used to find lengths, angles, areas, distances, volumes and centroids of solids.

9. **Circumscribed:**

   To draw a line around.

10. **Join:**

    Join unites curves that meet at a common end, making a single curve. Join can unite curves that do not touch, if you select them after the command has started.

11. **Scale:**

    Changes the size of existing objects without changing their shape.

12. **Array:**

    Use Array commands to make multiple copies of selected objects.

13. **Offset:**

    Offset creates an object parallel or concentric to another object.

14. **Perpendicular:**

    Standing at right angles to the plane of the horizon, meeting another line at a right angle.

15. **Viewports:**

    Displays different views of the model within the graphics area.

16. **Command line:**

    Lists commands you enter and information produced.

17. **Status bar:**

    Displays the coordinates of the pointer, the status of the model, options, and toggles.

18. **Flyout toolbar:**

    Sub-toolbar that includes options. Buttons that have flyout toolbars are marked with a small white triangle in the lower corner.

19. **Ortho:**

    Restricts the movement of the cursor to specific angles. Normal angle is 90 degrees.

Rhino Quiz #2

Define the following Rhino commands:

1. Patch:

2. Sweep 1:

3. Sweep 2:

4. Fillet Edge:

5. Rail Revolve:

6. Plane:

7. Extrude:

8. Loft:

9. Revolve:

10. Blend Surface:

Answer the following questions:

1. If you wanted to put a smooth end cap on an irregularly shaped surface what command would you use?

2. What is Boolean Union used for?

3. What is Boolean Difference used for?

4. What is Boolean intersection used for?

5. True or False?

   You would use cap planar holes to close simple planar holes in a surface or partial solid.

6. True or False?

   Extrude surface creates a solid by extruding a surface horizontally.

7. True or False?

   An Ellipsoid would be a good choice if you were drawing an perfect circle.

8. True or False?

   Surfaces have area, but their shape can not be changed by moving control point, and they can not be meshed.

9. True or False?

   Loft creates a surface from shape curves. The normal option makes a surface with creases as it passes over the shape curves.

10. True or False?

    A Rhino surface is like a piece of stretchy fabric. It can take on many different shapes.

Rhino Quiz #2 — Instructor Copy

Define the following Rhino commands:

1. **Patch:**

   Creates a surface that goes through a set of curves and or point objects.

2. **Sweep 1:**

   Creates a surface from shape curves that follows along a rail curve. This command controls one edge of the surface.

3. **Sweep 2:**

   Creates a surface from shape curves that follows along two rail curves. The two-rail sweep allows you to control the surface's edges.

4. **Fillet Edge:**

   Creates a fillet or round on the edge of a polysurface or solid.

5. **Rail Revolve:**

   Revolves a shape curve holding one end along a rail curve. This command is very useful for putting a smooth end cap on an irregularly shaped surface.

6. **Plane:**

   Creates a rectangular planar surface parallel to the construction plane from two diagonal points.

7. **Extrude:**

   Extrudes a curve perpendicular to the construction plane with the option to taper the surface with a draft angle.

8. **Loft:**

   Creates a surface from shape curves; the normal option makes a surface with no creases as it passes over the shape curves.

9. **Revolve:**

   Revolve a curve around an axis to create a surface.

10. **Blend Surface:**

    Makes a smooth surface between two existing surfaces.

Answer the following questions:

1. If you wanted to put a smooth end cap on an irregularly shaped surface what command would you use?

   Rail Revolve.

2. What is Boolean Union used for?

   To combine solids.

3. What is Boolean Difference used for?

   To subtract surfaces and solids from one another.

4. What is Boolean intersection used for?

   To create an intersection between surfaces or solids.

5. **True** or False?

   You would use cap planar holes to close simple planar holes in a surface or partial solid.

6. True or **False**?

   Extrude surface creates a solid by extruding a surface horizontally.

7. True or **False**?

   An Ellipsoid would be a good choice if you were drawing a perfect circle.

8. True or **False**?

   Surfaces have area, but their shape can not be changed by moving control points, and they can not be meshed.

9. True or **False**?

   Loft creates a surface from shape curves. The normal option makes a surface with creases as it passes over the shape curves.

10. **True** or False?

    A Rhino surface is like a piece of stretchy fabric. It can take on many different shapes.

Rhino Midterm Exam

Matching: (1 pt. ea.)

1. _____ Are used to find lengths, angles, areas, distances, volumes and centroids of solids.
2. _____ Lets you pick points that are off the construction plane. Requires two points to completely define the point.
3. _____ Creates a copy of the objects flipped over a specified axis on the construction plane.
4. _____ Unites curves that meet at a common end, making a single curve. It can unite curves that do not touch, if you select them after the command has started.
5. _____ Lengthens an object to make it end precisely at its intersection with another object or you can lengthen an object when there is no intersection.
6. _____ Connects two curves by extending or trimming them to intersect or to join with a beveled line. Works on convergent or intersecting lines.
7. _____ Tools for selecting specific points on existing objects.
8. _____ Connects two lines, arcs, circles or curves extending or trimming them to intersect or to join with a circular arc.
9. _____ To draw a line around.
10. _____ Divides one object with another, or a curve at a point. Divides the object where it intersects of the cutting object, but does not delete anything.
11. _____ Changes the size of existing objects without changing their shape.
12. _____ Makes multiple copies of selected objects.
13. _____ Displays the coordinates of the pointer, the status of the model, options, and toggles.
14. _____ Sub-toolbars that include different options. Buttons are marked with a small white triangle in the lower corner.
15. _____ Standing at right angles to the plane of the horizon, meeting another line at a right angle.
16. _____ Displays different views of the model within the graphics area.
17. _____ Restricts the movement of the cursor to specific angles. Normal angle is 90 degrees.
18. _____ Lists commands you enter and information produced.
19. _____ Creates an object parallel or concentric to another object.
20. _____ Making contact at a single point or along a line, touching but not intersecting.

Match these terms

A / Split	H / Scale	O / Command history
B / Perpendicular	I / Status bar	P / Viewports
C / Mirror command	J / Fillet	Q / Flyout toolbar
D / Object snaps	K / Join	R / Copy
E / Ortho mode	L / Elevator mode	S / Circumscribe
F / Tangent	M / Analysis tools	T / Chamfer
G / Extend	N / Offset	

True / False (1 pt. ea.)

1. _____ All NURBS surfaces contain curves.
2. _____ All surfaces can be edited by moving their control points.
3. _____ Surfaces can only be untrimmed.
4. _____ Parameter lines on a surface can also be referred to as isoparams.
5. _____ If two or more surfaces are joined together, but do not enclose a volume, the resulting object is a solid.
6. _____ The arrow keys in Rhino nudge your page view up, down, left, and right.
7. _____ In Rhino all surfaces are not 3D NURBS.
8. _____ You can not turn on the control points on single surface solids.
9. _____ You can use point editing on meshes, curves, and surfaces.
10. _____ Polysurfaces can be edited by using control points.

1. What are the five fundamental geometric objects in Rhino: (5pts)

   A.

   B.

   C.

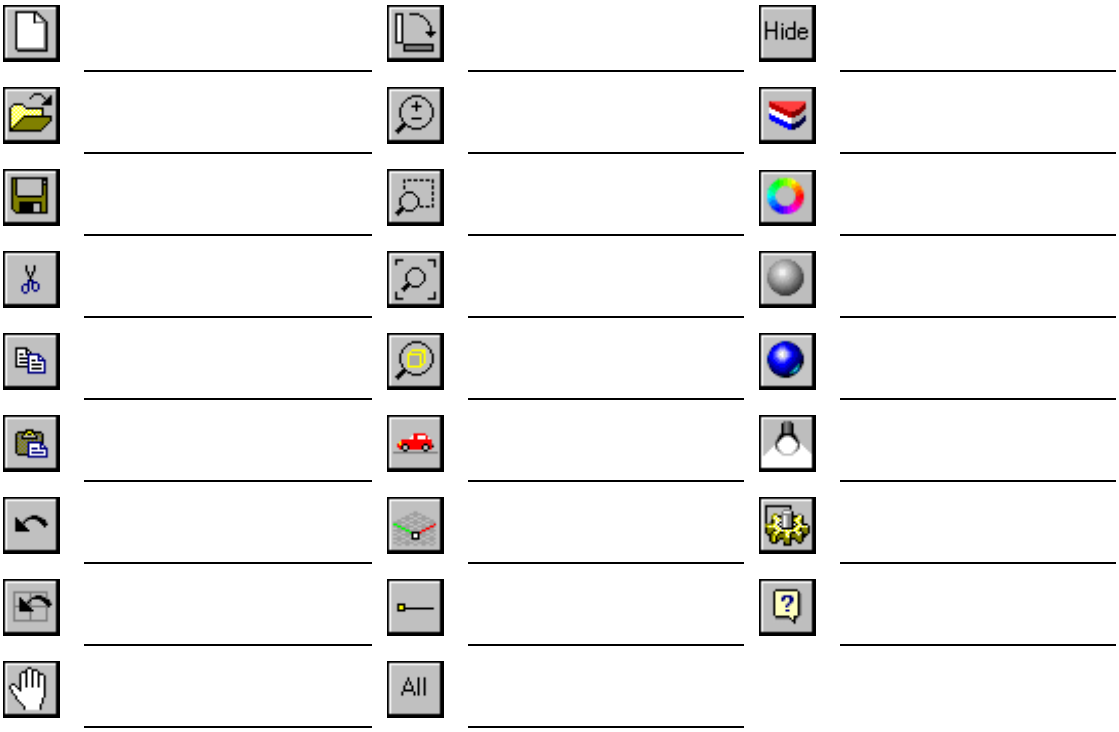
   D.

   E.

2. Explain how to make a background bitmap, and how to place it into Rhino. (5pts)

Match each of the buttons on the main toolbar with its command. (10 pts.)

Button



Command

Copy	Open file	Set CPlane origin
Create spotlight	Options	Shade
Cut	Pan	Undo
Edit layers	Paste	Undo view change
Help	Render	Zoom
Hide objects	Right view	Zoom extents
New file	Rotate	Zoom selected
Object properties	Save	Zoom window
Object snap	Select all	

EXTRA CREDIT: What does NURBS stand for?

Rhino Midterm Exam — Instructors Copy

Matching: (1 pt. ea.)

1.	M / Analysis tools	Are used to find lengths, angles, areas, distances, volumes and centroids of solids.
2.	L / Elevator mode	Lets you pick points that are off the construction plane. Requires two points to completely define the point.
3.	C / Mirror	Creates a copy of the objects flipped over a specified axis on the construction plane.
4.	K / Join	Unites curves that meet at a common end, making a single curve. It can unite curves that do not touch, if you select them after the command has started.
5.	G / Extend	Lengthens an object to make it end precisely at its intersection with another object or you can lengthen an object when there is no intersection.
6.	T / Chamfer	Connects two curves by extending or trimming them to intersect or to join with a beveled line. Works on convergent or intersecting lines.
7.	D / Object snaps	Tools for selecting specific points on existing objects.
8.	J / Fillet	Connects two lines, arcs, circles or curves extending or trimming them to intersect or to join with a circular arc.
9.	S / Circumscribe	To draw a line around.
10.	A / Split	Divides one object with another, or a curve at a point. Divides the object where it intersects of the cutting object, but does not delete anything.
11.	H / Scale	Changes the size of existing objects without changing their shape.
12.	R / Copy	Makes multiple copies of selected objects.
13.	I / Status bar	Displays the coordinates of the pointer, the status of the model, options, and toggles.
14.	Q / Flyout toolbar	Sub-toolbars that include different options. Buttons are marked with a small white triangle in the lower corner.
15.	B / Perpendicular	Standing at right angles to the plane of the horizon, meeting another line at a right angle.
16.	P / Viewports	Displays different views of the model within the graphics area.
17.	E / Ortho mode	Restricts the movement of the cursor to specific angles. Normal angle is 90 degrees.
18.	O / Command history	Lists commands you enter and information produced.

19. N / Offset — Creates an object parallel or concentric to another object.

20. F / Tangent — Making contact at a single point or along a line, touching but not intersecting.

True / False (1 pt. ea.)

1. T — All NURBS surfaces contain curves.
2. T — All surfaces can be edited by moving their control points.
3. F — Surfaces can only be untrimmed.
4. T — Parameter lines on a surface can also be referred to as isoparams.
5. F — If two or more surfaces are joined together, but do not enclose a volume, the resulting object is a solid.
6. F — The arrow keys in Rhino nudge your page view up, down, left, and right.
7. F — In Rhino all surfaces are not 3D NURBS.
8. F — You can not turn on the control points on single surface solids.
9. T — You can use point editing on meshes, curves, and surfaces.
10. F — Polysurfaces can be edited by using control points.

1. What are the five fundamental geometric objects in Rhino: (5pts)

   A. points

   B. curves

   C. surfaces

   D. solids

   E. polygon meshes, polysurfaces

2. Explain how to make a background bitmap, and how to place it into Rhino. (5pts)

   scan a photo

   bring it into Photoshop

   change the mode to b/w

   save a copy as a jpeg

   in Rhino go to view

   background bitmap, place

   click on the viewport

   make a box

Match each of the buttons on the main toolbar with its command. (10 pts.)

Button		Button		Button	
	New file		Rotate		Hide objects
	Open file		Zoom		Edit layers
	Save		Zoom window		Object properties
	Cut		Zoom extents		Shade
	Copy to Clipboard		Zoom selected		Render
	Paste		Right view		Create spotlight
	Undo		Set CPlane origin		Options
	Undo view change		Object snap		Help
	Pan		Select all		

EXTRA CREDIT: What does NURBS stand for?

Non-uniform rational B-spline

Rhino Final Exam

Match the following Rhino commands:

1. _____ Are used to find lengths, angles, areas, distances, volumes and centroids of solids.
2. _____ Creates a surface from shape curves that follows along a rail curve. This command controls one edge of the surface.
3. _____ Standing at right angles to the plane of the horizon, meeting another line at a right angle.
4. _____ Creates a round on the edge of a polysurface or solid.
5. _____ Unites curves that meet at a common end, making a single curve. It can unite curves that do not touch, if you select them after the command has started.
6. _____ Revolves a shape curve holding one end along a rail curve.
7. _____ Extrudes a curve perpendicular to the construction plane with the option to taper the surface with a draft angle.
8. _____ Creates a surface from shape curves; the normal option makes a surface with no creases as it passes over the shape curves.
9. _____ Makes a curve around a axis to create a surface.
10. _____ Makes a smooth surface between two existing surfaces.
11. _____ Creates a copy of the objects flipped over a specified axis on the construction plane.
12. _____ Creates a surface from shape curves that follows along two rail curves. The two rail sweep allows you to control the surface's edges.
13. _____ Creates a rectangular flat surface parallel to the construction plane from two diagonal points.
14. _____ Lists commands you enter and information produced.
15. _____ Creates a surface that goes through a set of curves and or point objects.

Match these terms

A / Blend Surface

B / Sweep 1

C / Extrude

D / Sweep 2

E / Loft

F / Mirror

G / Scale

H / Command line

I / Analysis commands

J / Extend

K / Chamfer

L / Object Snaps

M / Fillet

N / Fillet Edge

O / Circumscribed

P / Elevator Mode

Q / Revolve

R / Perpendicular

S / Split

T / Plane

U / Patch

V / Array

W / Status bar

X / Flyout toolbar

Y / Join

Z / RailRevolve

AB / Viewports

BC / Ortho

CD / Offset

DE / Tangent

For 5 points

What are the five fundamental geometric objects, NOT SHAPES in Rhino:

1.

2.

3.

4.

5.

For 5 points

Why are man-hole covers round? Explain in a paragraph. Think about this one.

Computer Section Timed: 30 minutes

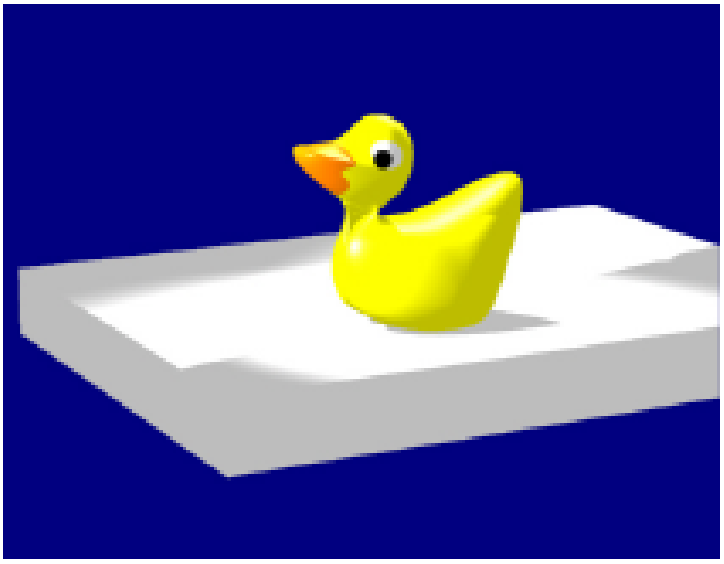
Re-create the duck model.

Now that you are Rhino experts you should be able to re-create the duck that we worked on in class.

You will do the following:

1. Create a simple surface.
2. Rebuild the surface (so it will have control points).
3. Edit surface control points.
4. Draw a project curve.
5. Split a surface.

6. Blend between two surfaces.
7. Light and render the model.
8. Print out in wire frame and in a rendered view.



I am more interested that you complete the above steps than if your duck looks great.

Rhino Final Exam — Instructors Copy

Match the following Rhino commands:

1.	I / analysis commands	Are used to find lengths, angles, areas, distances, volumes and centroids of solids.
2.	B / Sweep 1	Creates a surface from shape curves that follows along a rail curve. This command controls one edge of the surface.
3.	R / Perpendicular	Standing at right angles to the plane of the horizon, meeting another line at a right angle.
4.	M / Fillet	Creates a round on the edge of a polysurface or solid.
5.	Y / Join	Unites curves that meet at a common end, making a single curve. It can unite curves that do not touch, if you select them after the command has started.
6.	Z / RailRevolve	Revolves a shape curve holding one end along a rail curve.
7.	C / Extrude	Extrudes a curve perpendicular to the construction plane with the option to taper the surface with a draft angle.
8.	E / Loft	Creates a surface from shape curves; the normal option makes a surface with no creases as it passes over the shape curves.
9.	Q / Revolve	Makes a curve around an axis to create a surface.
10.	A / Blend Surface	Makes a smooth surface between two existing surfaces.
11.	F / Mirror	Creates a copy of the objects flipped over a specified axis on the construction plane.
12.	D / Sweep 2	Creates a surface from shape curves that follows along two rail curves. The two-rail sweep allows you to control the surface's edges.
13.	T / Plane	Creates a rectangular flat surface parallel to the construction plane from two diagonal points.
14.	H / Command line	Lists commands you enter and information produced.
15.	U / Patch	Creates a surface that goes through a set of curves and or point objects.

For 5 points

What are the five fundamental geometric objects, NOT SHAPES in Rhino:

1. Surfaces
2. Polysurfaces
3. Curves
4. Points
5. Solids

For 5 points

Why are manhole covers round? Explain in a paragraph. Think about this one.

It's the only shape that won't fall through the hole at any angle.

(Creative thinking question, you may receive many different answers.)

Computer Section Timed: 30 minutes

Re-create the duck model.

Now that you are Rhino experts you should be able to re-create the duck that we worked on in class.

You will do the following:

1. Create a simple surface.
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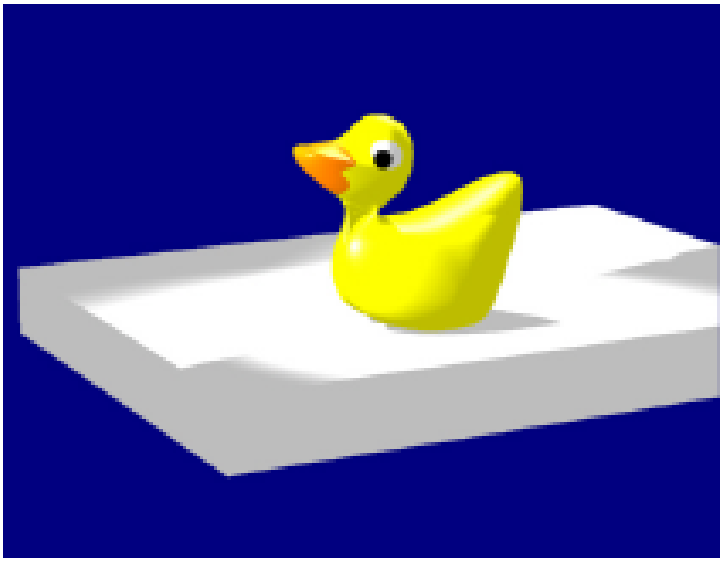

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